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Title: Contribution to USNB Comments on the JPEG-2000 Part 2 CD (wg1n1851)  
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*All cross-references are to the CD's labels.*

*This is an outline for a contribution to the USNB comments on the annexes listed below. I will generate proposed text (for inclusion with the USNB comments) following the outline below using the FCD PRA as a starting point, to be sure that I incorporate the most recent editorial changes to the Part 2 document.*

## **Contribution to USNB Comments on Annex G: Transformation of images, extensions**

- Throughout Annex G, replace the terminology “odd-length filter banks” by “whole-sample symmetric filter banks” (WS filter banks) and “even-length filter banks” by “half-sample symmetric filter banks” (HS filter banks). Since impulse responses are not used normatively in filter bank definitions, the notions of even- vs. odd-length filters are never defined normatively, whereas the notions of whole- vs. half-sample symmetry can be defined via the symmetric extension operations. E.g., we can define WS filter banks as filter banks that use the whole-sample symmetric extension operator and that have lifting steps with certain symmetries, whereas HS filter banks are those that use the half-sample symmetric extension operator and have different symmetry properties for their lifting steps. The relation to familiar impulse response characteristics can be made in informative paragraphs.

### **G.1 One-dimensional wavelet transformation options**

1. Add a high-level block diagram of the 1-D filtering process that shows modularity at the level of the lifting steps. This diagram should indicate how the modules depend on the key parameters in Table G-1: Filt\_Cat and Filt\_Typ. At present there's a great deal of confusing subscripting to indicate whether a procedure is specialized for reversible or irreversible and whole- or half-sample symmetric filter banks, but there's no high-level road map to this maze.
2. The fact that the  $1D\_S\{R,D\}$  procedures consist of extension followed by filtering is common to both WS and HS filter banks, and parallels Part 1 perfectly. Thus, the general  $1D\_S\{R,D\}$  procedures should be depicted in Section G.1, with the specialization of the procedures for WS/HS filter banks and reversible/irreversible cases given in later sections.

### **G.2 Signaling and interpretation of wavelet transformation parameters**

1. Simplicity being a great virtue, it is highly desirable to minimize the number of parameters signaled in Table G-1. It is also desirable to minimize the number that are signaled only in special cases.
  - a. It is sufficient to transmit a single scaling parameter,  $K$ , rather than signaling both  $K_0$  and  $K_1$ . Since we are following the lifting conventions of Daubechies and Sweldens, all filter banks should be normalized so that the polyphase determinant is 1, which forces the scaling parameters to be  $K$  and  $1/K$ .
  - b. The parameter  $N_{SS}$  (number of scaling factors) proposed at Marco Island is therefore unnecessary since signaling  $N_{SS} = 0$  (e.g., for the 5-3 filter bank) is no simpler than signaling  $K = 1$ , which could signal an efficient filter bank implementation to skip the scaling step and which would yield the correct results if performed naively by a less-sophisticated implementation.

- c. The HS category is the only one that uses lifting steps with different types of weight sequence symmetry, but rather than transmitting a separate  $s_{sym}$  parameter for every step in an HS filter bank it would be simpler to replace the multiple  $s_{sym}$ 's with a single parameter (e.g.,  $non\_sym$ ) to indicate the number of non-symmetric lifting steps at the beginning of an HS filter bank. Thus, an HS filter bank would have non-symmetric weight sequences  $\alpha_s$  for  $0 \leq s < non\_sym$ , and it would have whole-sample antisymmetric weight sequences for  $non\_sym \leq s < s_{len}$ . This is sufficient for signaling lifting factorizations of completely arbitrary HS filter banks. Note that  $non\_sym$  is unnecessary for nonlinear phase filter banks ( $Filt\_Cat = 0$ ) since we can assume that *all* lifting steps are non-symmetric in the nonlinear phase category.
2. The  $s_{off}$  parameter (offset of the filter in lifting step  $s$ ) is only needed for non-symmetric lifting steps, which only occur in HS and nonlinear phase filter banks.
3. With the above changes, the only parameters that would *not* be signaled for every filter bank, regardless of category, would be  $non\_sym$ ,  $s_{off}$ ,  $\epsilon_s$  and  $\beta_s$ . The  $non\_sym$  parameter would only be needed for the HS category, and the betas and epsilons are only needed for reversible filter banks.
4. The beta and epsilon parameters for reversible filter banks are the same for both decomposition and reconstruction and do not need to be signaled twice. Also, the betas need to be signed rather than unsigned.
5. According to Table A-17, we're using IEEE Standard 754 for signaling floating point parameters; mention this fact here in Annex G. This format should be used consistently throughout the standard (e.g., in the Multicomponent Annex).
6. Explain where in the codestream the selection of optional filter banks is signaled.
7. Update Annex A.3.3 (Arbitrary transformation kernels) with any changes to the signaling parameters.

## **G.2a (NEW SECTION) Definition of lifting steps**

1. Define the action of a general lifting step without any assumptions about the symmetry of the weight sequence, as was done in the 1D\_STEP procedures defined in Brislawn's August 17 draft. This is necessary to accommodate the non-symmetric weight sequences in the initial lifting steps at the start of an HS filter bank.
2. Give lifting step definitions that account for the symmetry of the weight sequences  $\alpha_{s,k}$  in the WS and HS cases. The CD currently makes use of the fact that weight sequences for lifting steps in a WS filter bank are half-sample

symmetric, but the analogous property for HS filter banks has not been presented yet; i.e., that (from some point on) the weight sequences are whole-sample antisymmetric. (cf. comment G.2-1c) Include an informative comment explaining that these definitions correspond to applying the filter given by unfolding the symmetric weight sequence appropriately.

3. Point out that the only difference between decomposition and reconstruction lifting steps is in the sign of the modification applied to the subsequence and the reversed order of the lifting steps.

### **G.3 One-dimensional subband reconstruction procedures for odd-length filters**

1. Change “odd-length filters” to “whole-sample symmetric (WS) filter banks.” The E/O subscripts (indicating “even/odd”-length filters) should also be changed.
2. I have not yet double-checked the formulas for the  $B_i$  parameters.
3. I like the approach of defining an infinite, periodic extension of the input vector via a function like PSE and specifying the range of filter bank outputs that need to be computed, making use of as much of the extended input as necessary. With infinite, periodic extensions defined, it seems that we could avoid having to compute the minimum extension lengths to the left and right for arbitrary filter banks by simply stating that implementations should use as much of the extension as necessary to compute the specified outputs. Incidentally, this is essentially what the VM does.

### **G.4 One-dimensional subband reconstruction procedures for even-length filters**

1. All of the comments for G.3 apply to G.4 as well.
2. Add an informative comment clarifying the def. of the PSE function, including Table G-2 and Figure G-7 (normative examples?!) in the comment. I’d suggest making the Table and Figure correspond to the exact same example, so they’ll reinforce one another.
3. The inverse 2-point transforms need to be added as a preprocessing step following the extension process but preceding the HS filter bank.
4. I have not double-checked the  $PSE_E$  or  $1D\_EXTR_E$  procedures. The latter is certainly wrong because the highpass subbands are antisymmetric, not symmetric.

### **G.5 One-dimensional subband decomposition procedures for odd-length filters**

1. Change “odd-length filters” to “whole-sample symmetric (WS) filter banks” and change the O subscripts.

2. See comment G.3-3.

## **G.6 One-dimensional subband decomposition procedures for even-length filters**

1. Change “even-length filters” to “half-sample symmetric (HS) filter banks” and change the E subscripts.
2. See comment G.3-3.
3. The 1D\_EXTR and 1D\_EXTD procedures are different for HS filter banks. See comment G.4-4.
4. The 2-point postprocessing transforms need to be added.

## **G.7 Examples of optional filter banks (informative)**

1. Organize this section into subsections that make sense; e.g., subsections for the WS and HS filter bank categories, then subsubsections for reversible vs. irreversible types within each category.
2. Include signaling for both the reversible and irreversible variants of the 5-3 filter bank and the 9-7 irreversible from Part 1.

## **Contribution to USNB Comments on Annex H: Single sample overlap discrete wavelet transform, extensions**

### **H.1 The Single Sample Overlap Inverse Discrete Wavelet Transformation (SSO-IDWT)**

1. Add a block diagram, similar to the one suggested for Section G.1, showing that symmetric extension is performed before *every* lifting step in the SSO-{I}DWT, in contrast to the definitions in Annex G in which extension is performed once, before the 1D\_FILTR procedures. This is really a change in the high-level structure of the 1D\_S{R,D} procedures since extension is interleaved inbetween lifting steps in the SSO-{I}DWT.
2. Where is *Cell\_size* defined?
3. Subscript typo in eq. H.4.
4. Why is step H.6 necessary? It says to apply a gain of  $B_k$  to the leftmost output sample, but only if  $B_k=1$ , which means this step does nothing! Careful proofreading of the algorithm is needed here.
5. Move the examples involving specific filter banks to an informative section at the end of Annex H, similar to Annex G.
6. Move the paragraph on signaling out of H.1 into a section of its own (H.0), similar to Annex G. Explicitly state the limitations on admissible SSOWT filter banks in terms of the Table G-1 parameters.
7. Move the paragraphs on partitioning of tiles into cells and overlapping blocks into a section of its own (H.0a).
8. Clarify the relationship between overlapping SSOWT blocks and the interval partitions  $I_p$  mentioned in the paragraphs that describe the filtering. It isn't at all clear which pieces of the image the SSOWT arithmetic operations get applied to, nor is it clear where the intervals  $I_p$  are defined that occur in the description of filtering operations.

### **H.2 The Single Sample Overlap Forward Discrete Wavelet Transformation (SSO-FDWT)**

1. See comments for H.1.
2. Move examples to the end of Annex H.

### **H.3 The Inverse Discrete Wavelet Transformation for Single Sample Overlapping Tiles (TSSO-IDWT)**

1. Move examples to the end of Annex H.

### **H.4 The Forward Discrete Wavelet Transformation for Single Sample Overlapping Tiles (TSSO-FDWT)**

1. Move examples to the end of Annex H.

Generally: can we come up with a Single-Sample Overlapping Tile algorithm that will work with HS filter banks?

## **Contribution to USNB Comments on Annex I: Multiple component transformations, extensions**

### **I.3 Multi-dimensional wavelet transforms**

1. This section essentially remains to be written, making use of the filtering procedures defined in other Annexes and defining any new filtering procedures that are unique to component decorrelation applications.
2. Annex I options discussed at Marco Is. that may affect component-decorrelating wavelet transforms include:
  - a. Grouping components into subsets and applying different, user-specified transforms to different component subsets.
  - b. Enabling resolution scalability across component subset boundaries in the cross-component dimension.
  - c. Enabling the use of nonlinear phase filter banks for component decorrelation (will require new boundary-handling algorithms not included in Annex G).

**Contribution to USNB Comments on Annex K:  
Region-of-interest coding and extraction, extensions**

**K.2 ROI mask generation**

1. Proofread Tables K-2 and K-3 for filter supports for the 9-7 and 5-3 filter banks.
2. Provide algorithms for computing supports of arbitrary optional filter banks.